Computational Assesments of Scenarios of Change in the Delta Ecosystem

CALFED Science Program Project SCI-05-C01-84
Semiannual Project Report
Report No. 2: September 1, 2006 – February 28, 2007

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Project Location: U.S. Geological Survey, Menlo Park, CA

Brief Description of Project: This project constitutes a model-based approach for developing a long view of the Bay-Delta-River-Watershed system. The long view is developed through simulations with linked models to project changes under a range of plausible scenarios of climate change, Delta configurational changes, and land-use/population change. Elements of the Bay-Delta River-Watershed system addressed by this project are:

① Climate Modeling and Downscaling
② Sacramento-San Joaquin Watershed and San Francisco Bay Modeling
③ Delta Modeling: Hydrodynamics with Temperature and Phytoplankton
④ Sediment, Geomorphology and Tidal-Habitat Modeling
⑤ Fate and Effects of Selenium, Mercury, Silver and Cadmium
⑥ Invasive Species– *Potamocorbula*, *Corbicula*, and *Egeria*
⑦ Native and Alien Fish Population Trends

The cascading effects of changes under these scenarios will be followed as they propagate through these elements, from the climate system to watersheds to river networks to the Delta and San Francisco Bay.

BUDGET SUMMARY (All tasks should exactly match those identified in the project Scope of Work.)

Task #	% Complete (by dollars)	Amount Invoiced (Current Fiscal Year)	Amount Invoiced to Date (All Years)	Projected Expenditures next 6 months
1	1%	1994.25	1994.25	40000
2	27%	55094.87	105792.08	130000
3	19%	0	44820.55	40000
4	12%	0	38523.00	46000
5	0%	0	0	18000
6	4%	928.80	3144.46	12000
7	8%	0	21222.49	30000
8	3%	0	1429.20	5000

PROJECT-WIDE STATUS

September 2006 through February 2007

ACHIEVED OBJECTIVES, FINDINGS, AND CONTRIBUTIONS: Team meetings were held regularly during this period, on Sept 8, Nov 6, and Dec 4 in 2006, and Jan 17 and Jan 29-30 in 2007. On Jan 29, the team provided a briefing to USGS managers, the CALFED Interim Science Lead, and the Chair of the Independent Science Board, along with project advisors and collaborators. This meeting and the PI meeting that followed on 1/30 were very productive for us, and the 1/29 agenda and our letter of response to our advisors are attached with this report.

Another particularly useful meeting held in the last six months was the Nov 6 meeting. The team performed an all-day "thought experiment" in which we considered the likely impact of a severe drought on the various systems under study in CASCaDE. This experiment was performed largely without the use of models and based primarily on the team's collective expertise and knowledge of the Bay-Delta system. This was effectively our first scenario run-through, and provided us with a much more detailed idea than we previously had of what will be involved in evaluating the actual scenarios of change. This meeting is discussed more in the Task 1 subsection.

Status, in brief, of individual tasks (detailed reports follow):

Task 1 (Climate): Downscaling procedures are in testing phase, results from a paleoclimate study will help in developing drought scenario, and an effort to hire a student to develop statistical models of Delta quantities to supplement Delta model runs is underway, though the focus has shifted to finding a student in the Bay area rather than in San Diego.

Task 2 (Watershed/hydrology): Preliminary inundation studies complete and presented at meetings, next phase underway. Effort continues to get CALSIM and stream temp models running locally, and a collaboration with USGS San Diego has begun which should provide better representations of agriculture and deep groundwater in Central Valley.

Task 3 (Delta hydrodynamics, temperature, and phytoplankton): The bathymetric grid for the Delta-TRIM model has been revised and data representing levee breach scenarios have been expanded, model development has continued, and meteorological data has been obtained and processed prior to provision to the climate component for use in developing downscaled quantities which will be used by Task 3.

Task 4 (Geomorphology/sediments): We have finalized the calibration of the geomorphic model to modern sediment flux data, constructed a historical sediment load time-series, and developed a computationally efficient time-stepping procedure for the hindcasting model.

Task 5 (Contaminants): More detail for this task's conceptual model was filled in.

Task 6 (Invasives): Model development continues, building on new results from a Delta-wide study and a continued literature review.

Task 7 (Fish): Continued literature review and model-building. Also a new postdoc has received a CALFED fellowship to join this CASCaDE task. See Task 7 report below for details.

Task 8 (Admin): Of note is the acquisition of a CASCaDE web server for internal use, and, eventually, to provide a more extensive public web presence.

Problems or Delays Encountered:

N. Monsen, the principal Delta hydrodynamic modeler, has been on leave since November and will return in March.

MILESTONES/DELIVERABLES:

- A journal article entitled "Calibration of an estuarine sediment transport model to measured cross-sectional sediment fluxes for robust simulation of geomorphic change", by Neil K. Ganju and David H. Schoellhamer was submitted to the proceedings of the 2006 Physics of Estuaries and Coastal Seas Conference, Astoria, Oregon, to appear in Continental Shelf Research.

- A journal article entitled "Reconstruction of daily sediment loads from the Sacramento/San Joaquin Delta, 1851-1959", by Neil K. Ganju, Noah Knowles, and David H. Schoellhamer was drafted.

- Malamud-Roam, F., Dettinger, M.D., Ingram, B.L., Hughes, M., and Florsheim, J., 2007, Holocene climates and connections between the San Francisco Bay estuary and its watershed: San Francisco Estuary and Watershed Science, 5(1), 28 p., http://repositories.cdlib.org/jmie/sfews/ vol5/iss1/art3

- Two oral presentations by Noah Knowles titled "Projecting Inundation In the San Francisco Bay-Delta Due to Sea Level Rise" were presented at the 3rd annual California Climate Change Research Conference in September, and at the CALFED Science Conference in October.

PERSONNEL CHANGES:
None.

CONTRACT MODIFICATIONS:
None.

March 2006 through August 2006

ACHIEVED OBJECTIVES, FINDINGS, AND CONTRIBUTIONS: Most activity during the period covered by this semiannual report has centered on development of models and methods, as well as some data gathering and preliminary analysis. Task 1 (Climate/Downscaling) progress has mostly been in the areas of (a) extending and testing the downscaling method that will be used to turn global-climate-model outputs into local weather scenarios for other tasks, and (b) coordinating with other tasks as to what data they will require and what forms and processing of that data we will require in order to meet project needs. Task 2 (Watershed/Estuary Modeling) has focused on obtaining and configuring the various needed models, and some analysis of the impacts of sea level rise. Task 3 (Delta) has seen significant activity in the development/refinement of the hydrodynamic, phytoplankton, and temperature model components, laying the necessary groundwork for performing simulations under the proejct's scenarios. Task 4 (sediments/geomorphology) has made substantial progress in the development, calibration, and validation of a geomorphological model of Suisun Bay. Task 5 (Metals) has begun preliminary experiments to accomplish the necessary bioaccumulation modeling. Task 6 (Invasives) is compiling the environmental and bivalve data necessary to derive the bivalve biomass model parameters, has established the protocol for connecting the phytoplankton and bivalve models, has begun the analysis of recruitment and biomass data, and has worked with the modelers and GIS specialists on assigning grazing rates to the grid in the Delta Trim model. Task 7 (Fish) has performed an extensive literature review and has begun compiling physiological/habitat need data for species of interest, and has also initiated contact with other researchers on the issue of Egeria mapping in the Delta. Task 8 (Administration) has overseen organization of multiple team meetings, budget and report generation, and organization/updating of the project's internal website.

PROBLEMS OR DELAYS ENCOUNTERED:

Task 1 has had some difficulty in finding a suitable postdoctoral researcher to hire. This is considered a temporary problem.

MILESTONES/DELIVERABLES:

- Cayan, D.R., Bromirski, P., Hayhoe, K., Tyree, M., Dettinger, M., and Flick, R., submitted, Climate change and the potential for sea-level extremes along the California coast: f Climatic Change, 24 p.

- An abstract entitled "Calibration of an estuarine sediment transport model to measured cross-sectional sediment fluxes for robust simulation of geomorphic change", by Neil K. Ganju and David H. Schoellhamer was accepted for an oral presentation at the 2006 Physics of Estuaries and Coastal Seas Conference, September 18-22, 2006, Astoria, Oregon.

- Two abstracts for oral presentations by Noah Knowles titled "Projecting Inundation In the San Francisco Bay-Delta Due to Sea Level Rise" have been accepted at the 3rd annual California Climate Change Research Conference in September, and at the CALFED Science Conference in October.

- Invited presentation to the Water Operations Management Team discussing the ramifications of decreased exports in fall and the possible implications that could have on the Pelagic Organism Decline – August 15 in Sacramento – J. Thompson

PERSONNEL CHANGES:

None.

CONTRACT MODIFICATIONS:

None.

PROJECT STATUS TO DATE (BY TASK)

This section should be a cumulative overview of the activities performed to date and include both current and past information for each task. Please list all new information at the top of each task section so that it is clear which information is the most recent. At the end of the project, this section will serve as a full historical record of all activities performed on the project.

TASK 1: CLIMATE MODELING AND DOWNSCALING

September 2006 through February 2007

This semester, Task 1 progress continued in the areas of (a) extending and testing the downscaling method that will be used to turn global-climate-model outputs into local weather scenarios for other tasks, and (b) coordinating with other tasks as to what data they will require and what forms and processing of that data we will require in order to meet project needs. (a) CASCaDE Task 1 will use our newly developed "method of constructed analogs" to transform output from very coarse resolution climate simulations into local weather time series that are statistically like observations that have more typically been used to drive models in other tasks. During this semester, Task 1 has contributed to revisions to the manuscript,

Hidalgo, H.G., Dettinger, M.D., and Cayan, D.R., submitted, Downscaling daily US precipitation and temperatures using constructed analogues: J. Climate, 24 p.

performed much more testing of the downscaling method in climate-change mode, that is, as applied to outputs from climate-model projections rather than on coarse-grid historical observations. Some new climate-change scenarios have been downscaled onto 12 km grids, in testing mode.

A mini-scenario was prepared for a CASCADE team meeting, to represent in temporal detail what a future drought might look like. Each of the several climate-change scenarios being considered by CASCADE was surveyed in order to find one with a severe (albeit brief) drought episode sometime around 2050. Two scenarios had such drought episodes, and we chose to provide team members with climate data from the warmer of the two candidates. Un-downscaled daily temperatures, precipitation, solar insolation, winds, and humidities were provided to team members for a climate-model grid cell near the Delta, for them to consider and try to discern potential effects in their respective models. These time series were focus of a team meeting on Nov 6, 2006, and helped to motivate several new CASCADE efforts, including a search for non-model indices that might be used to recognize future changes and thresholds (e.g., how often are there 5-day sustained warm and calm periods that might be expected to influence stratification and phytoplankton growth) and a compilation of key temporal scales and linkages within each of the scientific disciplines represented in CASCADE.

(b) Task 1 has continued its regular communications with team members from other Tasks, to determine which weather series the other Tasks will require and from which stations. In mid December, the other Tasks completed extraction of those observed time series for use in historical runs of their own models and for use by the downscaling effort of Task 1 These observation time series will be the training materials for the downscaling that Task 1 will be performing. The programming to downscale directly to station data, rather than gridded data as in Hidalgo et al (submitted, mentioned above) is almost complete.

Although its not really a Task 1 effort (having mostly been accomplished prior to the project), our new review of the paleoclimate literature for California:

Malamud-Roam, F., Dettinger, M.D., Ingram, B.L., Hughes, M., and Florsheim, J., 2007, Holocene climates and connections between the San Francisco Bay estuary and its watershed: San Francisco Estuary and Watershed Science, 5(1), 28 p., http://repositories.cdlib.org/jmie/sfews/ vol5/iss1/art3

has now been published. This is relevant to Task 1 because the review and data analysis it contains bears on our decision about how best to develop a climate scenario that mirrors the megadroughts of the medieval period, as one end member among the climate-change scenarios to be addressed within CASCaDE. Most relevantly, the paper demonstrates that the Sacrament and San Joaquin River flows during the megadrought periods did not include annual-runoff totals that were markedly less than those encountered during the historical period (fig. 6), but rather "just" included many more of the lower-historical-tercile runoff totals than have been encountered in the historical period. This means that we can draw analog years from the historical record, and should not need to constructed wholly new levels of dry years, when constructing detailed megadrought scenarios. Thus the next time we do a drought scenario, we can manufacture our own and provide pretty much complete spatial downscaled detail.

In September 2006, members of the Task 1 team participated and presented results in a meeting, called by UC Berkeley and Lawrence Livermore Laboratory economists, engineers, and scientists, to learn more about and present background regarding Delta Levee Risks from climate change, floods, and earthquakes. Team members organized and chaired three Climate Change sessions at the CALFED Science Conference in October 2006, and presented study results. Team members also presented results and plans to USGS management and CALFED leadership (Ott, Healey, and Mount) in January 2007, including discussions of what CASCADE will accomplish and what will be left to be resolved later.

As a result of discussions during our mini-scenario meeting in November, it became clear that a second track that will provide less-complete, but more readily computed, complements to the full Delta TRIM hydrodynamic model are needed by the project. Since Task 1 has had no luck hiring a post-doc to help with the downscaling efforts, and since we have decided that those tasks will have to be shouldered by team members already participating in the Task, we have agreed to help fund and to provide direction to a student (to be identified and hired, most likely through Mark Stacey at UC Berkeley) who will undertake the development of statistical models for prediction of some key water temperatures and salinities in the Delta, as a complement and extension of the Task 3 efforts. Team members in Menlo Park are coordinating with Stacey to see that we have a student working on this effort by summer.

March 2006 through August 2006

This semester, Task 1 progress has mostly been in the areas of (a) extending and testing the downscaling method that will be used to turn global-climate-model outputs into local weather scenarios for other tasks, and (b) coordinating with other tasks as to what data they will require and what forms and processing of that data we will require in order to meet project needs. (a) CASCaDE Task 1 will use our newly developed "method of constructed analogs" to transform output from very coarse resolution climate simulations into local weather time series that are statistically like observations that have more typically been used to drive models in other tasks. At the onset of the study, the method had been developed, tested extensively on historical data, tested cursorily on a climate change simulation, and the historical efforts documented in a manuscript:

Hidalgo, H.G., Dettinger, M.D., and Cayan, D.R., submitted, Downscaling daily US precipitation and temperatures using constructed analogues: J. Climate, 24 p.

During this semester, in coordination with a Scripps/Lawrence Livermore joint study, Task 1 has performed much more testing of the downscaling method in climate-change mode, that is, as applied to outputs from climate-model projections rather than on coarse-grid historical observations. A hundred years of "control run" (no changes in greenhouse gases) by the NCAR Parallel Climate Model has been provided by Lawrence Livermore (with more on the way) and has been downscaled and tested. Results are encouraging although it has become clear that the climate models have somewhat different weather characteristics than the real world, differences that can not really be fixed within the downscaling process. Those differences are fairly subtle and will be a fact of life, most likely, until the climate models themselves are improved.
Furthermore, a journal article describing the model that will be used to project sea levels under various scenarios of warming or just plain sea-level rise was completed and submitted to the journal:

Cayan, D.R., Bromirski, P., Hayhoe, K., Tyree, M., Dettinger, M., and Flick, R., submitted, Climate change and the potential for sea-level extremes along the California coast: f Climatic Change, 24 p.

(b) Task 1 has also been in regular communications with team members from other Tasks, to determine which weather series the other Tasks will require and from which stations. The other Tasks are extracting and providing those observed time series to Task 1 (still in progress) and then the observation time series will be the training materials for the downscaling that Task 1 will be performing.

Finally although its not really a Task 1 effort (having mostly been accomplished prior to the project), our new review of the paleoclimate literature for California:

Malamud-Roam, F., Dettinger, M.D., Ingram, B.L., Hughes, M., and Florsheim, J., in press, Holocene climates and connections between the San Francisco Bay estuary and its watershed: San Francisco Estuary and Watershed Science, 34 p.

Returned from journal reviews this semester and required minor revisions, including finalization of all the figures. The paper has now been accepted by the journal and should be out in the journal's next issue. This is relevant to Task 1 because the review and data analysis it contains bears on our decision about how best to develop a climate scenario that mirrors the megadroughts of the medieval period, as one end member among the climate-change scenarios to be addressed within CASCaDE. Most relevantly, the paper demonstrates that the Sacrament and San Joaquin River flows during the megadrought periods did not include annual-runoff totals that were markedly less than those encountered during the historical period, but rather "just" included many more of the lower-historical-tercile runoff totals than have been encountered in the historical period. This means that we can draw analog years from the historical record, and should not need to constructed wholly new levels of dry years, when constructing detailed megadrought scenarios.

TASK 2: WATERSHED AND ESTUARY MODELING

September 2006 through February 2007

The study of inundation due to sea level rise has completed the preliminary phase. Results were presented at the CALFED Science Conference and at the 2nd annual California Climate Change Conference. The next phase involves the development of a much more accurate elevation dataset, repeating the prior analysis using the data, and then taking the next step by refining our estimates of tidal bahavior under sea level rise using the TRIM model. Funding has been obtained from CALFED to develop the new dataset, and the necessary paperwork is being processed. Several agencies have expressed interest in this effort. Of particular interest is the possibility of providing the San Francisco Public Utilities Commission with estimates of the frequency with which sea water is likely to backflow into the storm drain system, causing water quality and urban flood-risk issues. The SFPUC has been contacted and will be "kept in the loop" regarding future results. Also, the BCDC, which has been pursuing a similar but complementary effort of their own, has been contacted and I (Noah Knowles) will meet with them on March 15th to initiate a closer collaboration to ensure each of our efforts continues to complement the other's.

Substantial revisions to the CALSIM code have been undertaken. The code has almost completely ported to the Linux operating system, which is a necessary step as all other models used by this task also run on Linux, and must be able to easily communicate results to and from CALSIM. Work continues on this port. The collaboration with Russ Yaworsky of USBR also continues to transfer their stream temperature model to our local computers. Significant progress on this front is expected in the next several months.

In a related project, the initial modifications to the BDWM watershed model to incorporate the BIOME-BGC vegetation model are nearly complete. A report detailing the capabilitites of the combined model is in progress. This improved modeling system will allow the hydrologic simulations under the CASCaDE scenarios to include the effects of vegetation on hydrology, a capability not available ni previous studies of the system's response to climate change.

Finally, communications have begun with Randy Hanson of USGS San Diego, who is part of a team developing a cutting-edge groundwater of Central Valley. Their team is also evaluating the effects of climate change, and we plan to join efforts to the extent possible. Their model includes deep groundwater, agricultural operations, aquifer drawdown and recharge, and surface operations in the Valley. All these components are only crudely represented in CASCaDE, and this collaboration should prove particularly beneficial to our efforts.

March 2006 through August 2006

The initial phase of the watershed and estuary modeling component of CASCaDE involved acquisition and initial configuration of the models to be employed by this component, as well as a GIS-based study of near-shore terrain elevations in order to assess which areas adjacent to the Bay-Delta are susceptible to inundation due to rising sea levels.

First, a two-dimensional version of the high-resolution hydrodynamic San Francisco Bay model, TRIM-2D, was obtained from Dr. Ralph Cheng (USGS) and configured to run on a local workstation. This model was then used to generate high-resolution current fields for use in calibrating a coarser box model of the Bay, the Uncles-Peterson (UP) model. The goal is to use TRIM-2D to generate calibration coefficients for the UP model which correspond to successinve increases of mean sea level. The corresponding analysis is in progress. TRIM-2D will also be used to estimate tidal ranges throughout the Bay, and to generate boundary conditions for DELTA-TRIM (Task 3) near Martinez.

Next, a hydrostatic wind model of surface winds in the Bay area was obtained (also from Dr. Cheng). This model may be used to generate wind fields in the region corresponding to the different climate scenarios, for use by other CASCaDE components, including the sediment/geomorphology component (Task 4).

Third, the model used to simulate reservoir operations, CALSIM-II, has been obtained and is being configured for the multiple runs which will be necessary for the CASCaDE project. The model source code is being reconfigured for this purpose. This reconfiguration is nearly complete. We have agreed to keep DWR Modeling Section informed of any changes we make to their code.

Fourth, our cooperator at USBR, Russell Yaworksy, has been re-contacted, and has agreed to assist us in setting up their CALSIM-compatible stream temperature model on our machines. With Russ' assistance, we will begin this work as soon as CALSIM-II is reconfigured and successfully running.

Finally, a study of areas around the Bay and Delta that are vulnerable to inundation by sea level rise is nearly complete as a first major deliverable from this Task. This study evaluates the effects of a projected sea level rise of 20-80 cm over the coming century, which will cause new areas surrounding the San Francisco Bay and Delta to be inundated, with a wide variety of ecological and socioeconomic consequences. Available elevation and land-use data are used to characterize the areas at greatest risk of inundation. The projected inundated areas are primarily intertidal. The dominant inundated land-use types are wetlands adjacent to the Bay and areas that are presently croplands around the Delta periphery. The effects of sea level rise would also combine with projected higher flood stages due to reduced snowpack and with continued land subsidence to significantly increase the risks of levee failure in and around the Delta. Results from this study will be presented at the 3rd annual California Climate Change Research Conference in September, and at the CALFED Science Conference in October.

TASK 3: DELTA MODELING: HYDRODYNAMICS, TEMPERATURE, AND PHYTOPLANKTON

September 2006 through February 2007

3.1 HYDRODYNAMIC MODELING

During this time period, we have continued various "nuts and bolts" activities necessary for moving us toward Delta production simulations. These activities include model refinement, development of ancillary tools for processing related data, and data gathering.

3.1.1 GIS Grid Improvements

The previous work with scientists in the USGS Geologic Division to convert aerial photographs into levee and dry land elevations continued during this period. Elevations for levees, currently dry Delta islands, and areas surrounding Suisun Marsh, have been merged with the original Delta bathymetry grid of currently wet(able) areas of Suisun Bay and the Delta and will be used in scenarios involving sea level rise or levee rupture.

A GIS based methodology was set up and transferred to CASCaDE scientists for editing the bathymetric grid. This will replace the previous outdate application used to perform this task.

3.2 PHYTOPLANKTON MODELING

3.2.1 GIS Grid Improvements

During this period, we continued work with Amy Mathie in the USGS Geologic Discipline to develop a GIS based method to 1) incorporate discrete measurments of benthic grazing rate, 2) overlay them on the bathymetry grid, then 3) interpolate between those measurements and produce a full grid of grazing rates for use in the model. Mathie tested several approaches for the interpolation and settled on one which will interpolate only along wet areas (i.e. not across dry land). Mathie trained Monsen and Lucas on how to implement this method and how to use the GIS software to manually edit grids of grazing rates. This overall approach should be useable for other biological input parameters for which discrete measurements are available but for which the model will require a fully populated grid.

3.2.2 Model Development

We continued to identify and trouble-shoot isolated numerical issues causing instabilities (e.g. at gates), so that rigorous accounting of mass can be performed. The new GIS tools have greatly assisted us in visualizing spurious model output and isolating numerical problems.

3.3 TEMPERATURE MODELING

3.3.1 Quality Control and Processing of Meteorological Data

Meteorological data (downloaded and preprocessed in the previous period) was checked for quality and reasonableness and was further processed to develop ancillary parameters (e.g. daily max or min). In all, 20-year time series for 14 parameters at 4 stations were delivered to Mike Dettinger for downscaling from global climate models to local climate scenarios for the future climate change cases we will ultimately run. This data is relevant to not only the water temperature model, but also to the phytoplankton and hydrodynamic models. The 14 meteorological parameters are:

1. Daily precipitation
2. Daily solar radiation
3. Daily average relative humidity
4. Daily min relative humidity
5. Daily max relative humidity
6. Daily average air temperature
7. Daily min air temperature
8. Daily max air temperature
9. Daily average dew point
10. Daily average vapor pressure
11. Daily average wind speed
12. Daily min wind speed
13. Daily max wind speed
14. Direction of daily max wind speed

3.3.2 Additional Simpler Empirical Models of Salinity and Temperature

Through the last few CASCaDE team meetings, it became evident that some of the “downstream” modeling components (e.g. bivalves, fish, egeria, contaminants) will need a method for predicting Delta salinity and water temperatures for a much larger ensemble of climate change scenarios than the detailed, computationally intensive DELTA-TRIM model can reasonably perform. We collectively discussed the idea of developing a “simpler” perhaps empirically based and computationally very efficient model of salinity and temperature that could be driven by outputs from the hydrologic and climate models. This simpler model would produce salinity and temperature distributions less detailed than what the TRIM model can calculate, but these coarser distributions should be of great use to the ecological components of CASCaDE. We have discussed this modeling need with Professor Mark Stacey at UC Berkeley, and he has agreed to work with us and a graduate student to develop this new modeling capability.

March 2006 through August 2006

3.1 HYDRODYNAMIC MODELING

In phase 1 of this project, we are laying the groundwork necessary to run the different scenarios. The major tasks for this 6 month period have been: A) improving the bathymetric grid and incorporating information about levee heights and island elevations, B) identifying the TRIM output required by ‘”downstream” models, and C) establishing communication with the Delta Risk Management Strategy (DRMS) program.

3.1.1 GIS Grid Improvements

Because the grid editing software currently used to update bathymetric data for TRIM was inadequate for the current application, we are changing our approach to use GIS. To do this migration, we obtained GIS help from the Geologic Division of the USGS/Menlo Park. The goals for the GIS work are to: a) establish a method to get the TRIM bathymetry grid in and out of GIS so we have a more robust editing system and b) create a method to interpolate benthic data for use in the phytoplankton modeling (see Subtask 2 below).

Significant additional information became available as a result of discussions during this process. The levee failure scenario requires knowledge of both levee heights around the islands and the elevations of the islands that would be flooded in the event of levee failure. An expert in the translation of aerial photography into digital elevations volunteered his time to translate recent photographs of the central and western regions of the Delta into a form that could be merged with the Delta TRIM bathymetric data. This information has been incorporated into the GIS database and will be translated into an expanded bathymetric grid for Delta TRIM. In addition, detailed elevation information for the marsh region around Suisun Bay was incorporated into the database. This is a region that may be inundated during sea level rise scenario. (See Figures 3.1-3.3.)

3.1.2 TRIM Outputs

All tasks that are “downstream” of the Delta TRIM model met on March 22, 2006 to discuss the output that each task will require. There were two primary issues discussed:

1) What time are we going to use as a base case?

Because of natural variability in this system, it is hard to define just one year to use as a basis for “current day.” We determined that defining the “current day” base case does not need to happen before starting work on the future scenario periods. However, TRIM scenarios need to run for a full year because of the unique characteristics of each season. For the calibration/verification of models (other than TRIM-hydro, phyto, temperature), we will used observed data rather than TRIM output.

Nancy Monsen, Jim Cloern, and Alan Jassby (UC/Davis) met subsequently to establish an approach to define distributions of key parameters in the historical past. We are currently using the BDAT database to establish distributions of data based on month, location and water year type.

2) What constituents are important outputs from the model?

The general conclusion was that we would like to store as much output from the model as possible to limit the number of TRIM runs. We will store the data on a server to which every group has assess. We ideally would like hourly data at each grid cell.

3.1.3 Establishing communication with DRMS program

Nancy Monsen attended a DRMS meeting at the URS Cop. Offices in Sacramento, CA on 5/8/2006. The purpose of this meeting was to discuss with the operators of the State Water Project and Central Valley Project how water project water management decisions would be made in the event of catastrophic levee failure. One of the agenda items was an overview of the DRMS program and what it is trying to accomplish and an overview of the water management modeling teams goals. The meeting allowed us to identify places where our work will overlap with DRMS and products that CASCaDE can produce that will assist the DRMS effort.

Since the meeting, Ralph Svetich (DWR, DRMS program manager) has been in contact with Nancy Monsen several times in order to convey information about their climate change scenario development. This information has been forwarded on to the appropriate people within the CASCaDE group.

3.2 PHYTOPLANKTON MODELING

3.2.1 GIS Grid Improvements

As mentioned above, we have begun work with colleagues in the USGS Geologic Division to obtain assistance in incorporating benthic (clam) grazing rate values at discrete measurement locations in the Delta from several previous CALFED funded studies so that, ultimately, interpolated maps of benthic grazing rate throughout the TRIM model domain could be generated for input to the model. So far, grazing rate and related information has been QC'ed, processed, incorporated into the GIS environment, and overlaid on the bathymetry grid for the model (see Figures 3.4-3.5).

3.2.2 Model Development

The existing biological portions of the TRIM code have been restructured and further modularized to increase compatibility with hydrodynamic and temperature modules. We have investigated and solved issues related to the grid and numerics causing, in isolated cases and usually near boundaries, negative phytoplankton concentrations. Work is continuing to develop a rigorous mass accounting procedure to assure the absence of any spurious (e.g. numerically induced) sources or sinks of phytoplankton biomass in the model and ensure strict mass conservation. Historical data for zooplankton biomass has been obtained, for use in calculating zooplankton grazing rates in the model. Lucas, Thompson and Parchaso have met twice to develop and refine strategies for coupling models of clams and phytoplankton.

3.3 TEMPERATURE MODELING

From June 2006-August 2006, Dr. Mark Stacey, associate professor of Civil/Environmental Engineering at the University of California/Berkeley provided technical assistance to further develop the temperature module component of TRIM. The priority temperature modeling tasks for 2006 were: A) Identify the meteorological stations within the Delta to be used to drive the temperature module, B) Develop a technique to translate daily temperature data into a diurnal signal, and C) Delta scale calibration.

3.3.1 Identify the meteorological stations to drive the temperature module

Four historical CIMIS stations were identified as stations that will be used to drive the temperature module:

Brentwood*	Central Delta	1985-2006
Manteca	South Delta	1987-2006
Nicolaus	North Delta	1983-2006
Davis	North Delta	1982-2006

* Primary station

All historical data (~20 years) for all stations was downloaded and processed into a form that can be used by Mike Dettinger (Task 1) to drive the model for future scenarios. The constituents for each station included:

Daily	**Hourly**
CIMIS Eto (mm)	CIMIS Eto (mm)
Precip (mm)	Precip (mm)
Sol Rad (W.sq.m)	Sol Rad (W.sq.m)
Avg vapor pressure (kPa)	Vapor pressure (kPa)
Air temp (degree C) (Max, Min, Avg)	Air temp (degree C)
Rel. humidity (%) (Max, Min, Avg)	Rel. humiditiy (%)
Dew point (degree C)	Dew point (degree C)
Avg. wind speed (m/s)	Wind speed (m/s)
Wind run (km)	Wind direction (km)
Avg soil temp (degree C)	Soil temp (degree C)

There are data quality flags on some of this data. We are going through a quality control process to identify gross outliers in the datasets. Once the quality control is complete, the data will be provided to Task 1 for processing for our specific scenarios.

3.3.2 Translate daily temperature data into a diurnal signal

For all scenarios, the watershed model will provide daily temperatures to drive the TRIM model. This information needs to be translated into a diurnal signal for model stability reasons. Dr. Stacey is developing a technique where a separate calculation is done outside the model domain for a “bathtub.” The output from this separate simulation will drive the model boundaries. This technique is still under development.

3.3.3 Calibration for full Delta domain

The first step in the process was to identify and fix a logic problem in the current code that was caused by the migration of the original code to the modular form of the code. The problem has been isolated to a small sub-section of the code.

TASK 4: SEDIMENTS/GEOMORPHOLOGY

September 2006 through February 2007

Calibration to modern flux data

The Suisun Bay geomorphic evolution model was calibrated to several years of modern sediment flux data: 1997, 1998, 2002, 2003, and 2004. An eight-parameter sensitivity test was also performed on the calibrated model. It was determined that the model was most sensitive to wave energy, due to the non-linear relationship between wave energy and bed shear stress. These efforts were presented at the 2006 Physics of Estuaries and Coastal Seas Conference, in Astoria, Oregon, and a manuscript was submitted to the conference volume, to appear in Continental Shelf Research.

Preliminary one-year scenario exercise

The aforementioned calibrated model was used to evaluate the effect of sea-level rise and flashier flows on sediment transport. This exercise was intended to provide a brief look at the model's response to simple changes in forcing. The main result was that the non-linear interaction between sea-level rise and hydrograph shape is important, and can contribute to significant changes in morphology, especially in the shallow portions of Grizzly and Honker Bays.

Hindcasting of bathymetric change

The hindcasting of 1867-1990 bathymetric change is dependent on formulation of historical load time-series, and a time-stepping procedure (detailed in last progress report). Both the load time-series and time-stepping procedure have been modified since the last progress report.

The methodology for generating the load time-series has remained unchanged, however the flow data used for matching historical hydographs was updated. We now use the unimpaired flow estimates generated by Noah Knowles' BDWM instead of Dayflow. This accurately represents the unimpaired nature of the hydrograph during the historical era (pre-1930). The unimpaired flow estimates are available for 1967-1987, which provides 21 years of possible matches. This revised approach is detailed in a journal article in preparation.

The time-stepping procedure has also been modified, to follow a more robust method. First, the hydrograph from each year is compared to four "prototype" hydrographs, each of which represents a frequently-occurring hydrograph shape. Each prototype hydrograph is then used to drive the geomorphic model separately, for a one-year period. The geomorphic results for each prototype are then superimposed (with weighting appropriate to the frequency of occurrence). This procedure will be tested for the 1867-1887 bathymetric change period.

March 2006 through August 2006

The four major activities which have been completed for this task are, in reverse chronological order, 1) development of historical boundary conditions for hindcast modeling of bathymetric change; 2) development of a time-stepping procedure to reduce computational load; 3) validation of the sediment transport model with recent sediment flux data; and 4) calibration of a sediment transport model to recent sediment flux data. These activities are all calibration/validation exercises, in order to ensure that future modeling of climate change scenarios are robust and sound. The details of these activities are listed below.

4.1 DEVELOPMENT OF HISTORICAL BOUNDARY CONDITIONS

Sediment load data are available for the upstream boundaries of the domain (Freeport and Vernalis on the Sacramento and San Joaquin Rivers, respectively) for periods beginning in 1959. Hindcasting simulations require sediment load data for 1867-1990, therefore a method must be found to estimate daily sediment loads for 1867-1959. The first step is acquiring freshwater flow data.

4.1.1 Determination of total yearly flow

The eight-river index (California Department of Water Resources) is a measure of unimpaired flow into the Delta, and prior to water exports this represents the total flow into the Delta. This record is available back to 1906. Meko et al. (2001) developed a yearly time-series of total Sacramento River and San Joaquin flow using tree-ring chronologies, for the period 868-1977. This provides an estimate of total flows for 1867-1906.

4.1.2 Construction of monthly hydrograph

Monthly total flows are available from the eight-river index, though combined values are provided for October/November, June/July, and August/September. Flow was split evenly between months with shared total flows. The monthly flows were compared with monthly precipitation totals from Sacramento, which span 1878-present. The total flow in a month was linearly regressed against the prior precipitation in the water year, for example, total January flow was regressed against total precipitation from October, November, December, and January. The regression spans 1906-1929, prior to major water diversions, when the eight-river index was a good measure of flow into the Delta. Using the regression equation with 1877-1906 precipitations data yields monthly flow estimates from 1877-1906.

4.1.3 Comparison of monthly hydrographs

It is assumed that two years with similar monthly hydrographs share similar daily hydrographs. Therefore, the shape of monthly hydrographs from 1877-1928 were compared to monthly hydrographs from the period 1929-present, where daily data are available. For example, the monthly hydrograph from water year 1890 was cross-correlated with each of the 75 hydrographs from 1929-2003. The hydrograph from 1929-2003 that matched the 1890 shape closest was selected as the corresponding year, say, 1945. The daily hydrograph from 1945 was then used as the daily hydrograph for 1890. Multipliers were applied, if necessary, to maintain the same total flow as estimated from prior steps.

4.1.4 Comparison of yearly total flow

For the period 1867-1877 there are limited precipitation data, so the total yearly flow was compared with the total yearly flow from 1929-2003. The year with the closest total flow was used as the surrogate daily hydrograph. Again, total flow was maintained.

4.1.5 Estimation of sediment loads

The sediment rating curve relationship $QC=aQ^b$, was used to estimate sediment loads. The coefficient “b” (represents the erosive stream power) was determined using 2000-2003 data, with a value of 1.13. Coefficient “a” represents the sediment supply, and was used as the calibration parameter. Calibration data are from Gilbert (1917) (7.4 Mt/y, for 1849-1914) and Porterfield (1980) (3.5 Mt/y for 1909-1966). While these numbers are period averages, coefficient “a” was modified to yield the same period averages using daily data. Both Gilbert (1917) and Porterfield (1980) provide volumetric load estimates, these were converted to mass load estimates using an average density of 529 kg/m^3 (Krone 1979).

4.2 DEVELOPMENT OF TIME-STEPPING PROCEDURE

Analysis of model results suggests that fluxes over the most dynamic periods (winter, summer) can be extrapolated individually to represent seasonal dynamics accurately. This procedure was tested for the two modeled water years. Two four-week periods were selected to represent 1) winter conditions (high freshwater flow with episodic wind-waves), and 2) summer conditions (low freshwater flow and steady diurnal wind-waves). The four-week period contains tidal variability due to the 14-day spring-neap cycle, which is critical for sediment transport processes. The center of the winter modeling period is determined as the time of peak sediment load, and two weeks are modeled before and after the peak. The fluxes are extrapolated for the time between elevated freshwater flow in the fall, and the return to baseline summer flow. The net sediment flux is then multiplied by a factor of 1/3, as this is the most dynamic period (the remainder of the winter is less dynamic). The beginning of the summer period is identified as the time at which baseline flows return, to the end of the water year. The temporal center is identified, and two weeks before and after are modeled. The same extrapolations are performed for the summer period. The two-season time-stepping method results in a net export of 2.96 Mt for 1997 as compared to the actual result of 2.74 Mt. These small deviations are minimal, and suggest that this time-stepping procedure is suitable for decadal-scale simulations, where computational expense must be minimized.

4.3 VALIDATION TO WATER YEAR 2004 FLUXES

The calibrated model is validated using flux data from water year 2004. Therefore we calibrate to a relatively dry period, and the mechanics of the model are validated during a much wetter period. Validation will be quantified in reference to simulating the correct net flux between Suisun Bay and the Delta (Mallard Island cross-section), and the correct net flux between Suisun Bay and Carquinez Strait (Benicia Bridge cross-section) within the error bounds of the flux measurements (McKee et al. 2006; Ganju and Schoellhamer in press). Preliminary model results compared well with sediment flux estimates as computed by McKee et al. (2006) and Ganju and Schoellhamer (in press) in terms of the seasonal pattern, with export during high flows and import during the summer low-flow season. However, the net sediment import for 2004 was estimated at 0.006 Mt by Ganju and Schoellhamer (in press), while the model results show a net export of 2.35 Mt. This discrepancy is attributed to poor agreement in the low-flow season, when landward dispersive flux is maximized. During this season, fluxes are extremely sensitive to the synthetic seaward sediment boundary condition. Future efforts will refine this boundary condition, especially for dry years.

4.4 CALIBRATION TO WATER YEAR 1997 FLUXES

The seaward suspended-sediment concentration boundary condition and sediment properties (i.e. bed shear strength, settling velocity, erosion rate) are calibrated to the water year 1997 data. This period contains peak freshwater flows that are 3.5 times greater than the 2004 period, and yearly cumulative flow is a factor of two larger. Therefore we will calibrate to a relatively extreme (in terms of freshwater flow) period, and the mechanics of the model will be validated during a drier period. Landward boundary conditions and the remaining seaward boundary conditions are specified as outlined above. Calibration goals are to simulate the correct net flux between Suisun Bay and the Delta (Mallard Island cross-section), and the correct net flux between Suisun Bay and Carquinez Strait (Benicia Bridge cross-section) within the error bounds of the flux measurements (McKee et al. 2006; Ganju and Schoellhamer in press). Model results compared well with sediment flux estimates as computed by McKee et al. (2006) and Ganju and Schoellhamer (in press). The seasonal pattern of sediment flux was represented, with export during high flows and import during the summer low-flow season. The net sediment export for 1997 was estimated at 2.83 Mt by Ganju and Schoellhamer (in press), while the model results show a net export of 2.74 Mt.

We have developed an estuarine geomorphic model based on a traditional tidal timescale hydrodynamic/sediment transport model, by idealizing boundary conditions, applying novel calibration procedures, and implementing a simplified time-stepping method. The Regional Oceanic Modeling System (ROMS) was developed for Suisun Bay, for the purpose of hindcasting historical geomorphic change and modeling future scenarios of geomorphic change. Seaward boundary conditions were idealized using tidal harmonic prediction for tidal stage and velocity, and a synthetic time-series for sediment concentrations was constructed by applying typical seasonal wind patterns and the spring-neap tidal signal. Calibration of these idealized boundary conditions and bed sediment parameters was accomplished using sediment flux data for the boundaries of Suisun Bay from water years 1997 and 2004. Calibrating to sediment fluxes guarantees that modeled net geomorphic change will not exceed the total supply of sediment from landward and seaward sources. The successful simulations of 1997 and 2004 allow for the development of a time-stepping method that reduces computational expense. The method involves simulating the two distinct sediment-transport seasons of Suisun Bay as month-long periods, then extrapolating the results of each compressed period for the entire season. Computational time for hindcasting and future scenario simulations is now reduced by 85% using this simplified method. Boundary conditions for the historical period were developed by analyzing proxies for freshwater flow and sediment loads. The sediment load time-series for the period 1867-1990 will allow for hindcasting simulations of bathymetric change.

An abstract entitled “Calibration of an estuarine sediment transport model to measured cross-sectional sediment fluxes for robust simulation of geomorphic change”, by Neil K. Ganju and David H. Schoellhamer was accepted for an oral presentation at the 2006 Physics of Estuaries and Coastal Seas Conference, September 18-22, 2006, Astoria, Oregon. This presentation details the calibration and validation procedure that was used to develop the geomorphic model; this same model will now be used for the hindcasting and scenarios modeling.

TASK 5: FATE AND EFFECTS OF METALS

September 2006 through February 2007

The primary progress this period was development and fleshing out of the conceptual model clarifying how climate change will affect the influence of Se and Hg in the estuary. Primary findings after assembling the model were that:

Shifts in relative inflows of the San Joaquin River and Sacramento River must be considered as influences on sources of the two metals. If SJR inflows increase relative to Sacramento inflows, then Se inputs will increase with impacts cascading through the food web. However, Hg inputs could decrease.

Factors that affect success of metal-vulnerable fish species will also have a cumulative effect with Se and Hg, but the effects differ among species and metals. Sturgeon are very vulnerable to any shifts Se and Hg inputs because a) both are reproductive toxin and Se are already likely to be affecting sturgeon, b) sturgeon have very low fecundity so any recruitment losses could have long –term implications. Shifts in climate that increase both Se and Hg could result in cumulative effects from the two toxins. Sacramento splittail on the other hand are very fecund but vulnerable in low flow years (when recruitment suffers as a result of habitat loss). Se effects on recruitment would affect splittail primarily in low flow years; becoming a cumulative impact of potential significance if extreme years or droughts become more frequent. Striped bass are unlikely to be affected by Se but are quite vulnerable to Hg, although population effect models must factor in their fecundity.

March 2006 through August 2006

Preliminary experiments to accomplish the necessary bioaccumulation modeling are underway. Crucial hyper-accumulators in the delta are being characterized (these are the best indicators). Species include the bivalve Corbicula and the snail Lymnaea sp. We will conduct the modeling work during the next fiscal year.

The following related papers have also been published:

Croteau, M.N., Luoma, S.N., and Stewart, A. R. Trophic Transfer of Metals Along Freshwater Food Webs: Evidence of Cadmium Biomagnification in Nature. Limnology and Oceanography, v. 50, 1511-1519, 2005.

Croteau, M.N., Luoma, S.N. Delineating Copper Accumulation Pathways for the Freshwater Bivalve Corbicula Using Stable Copper IsotopesEnvironmental Toxicology and Chemistry, V. 24, pp. 2871-2878. 2005.

TASK 6: INVASIVE SPECIES

September 2006 through March 2007

We continue to compile the environmental and bivalve data necessary to derive the model parameters. We are completing the analysis of *Corbicula* biomass to see if there is a relationship between bivalve growth rate and the transport of San Joaquin River-derived phytoplankton. We are writing up our analysis of Delta-wide *Corbicula* distribution (abundance and biomass) and show that the distribution of new recruits is related to flow conditions (they are present most places but in fewer numbers in the center of large rivers) and the distribution of adults is related to advected sources of phytoplankton and locally produced phytoplankton. The recent spread of *Corbula* up river with a change in fall water export schedules has allowed us to examine the fall recruitment and increased survival into adulthood of this bivalve during periods when salt water extends up river for a short time period and the analyses of this recent data are ongoing.

We are also acquiring literature estimates of growth, mortality and natality rates for *Corbicula* to compare them with the rates that we are deriving. We plan to run the model with a range of values from the literature to show the potential population size in this system if the clams were given sufficient food.

We have established a protocol for developing a statistical range of bivalve distributions for different scenarios. Based on statistical models of freshwater flowrate and salinity and temperature, we will develop a range of initial distributions for the bivalves for each scenario. Therefore we will be able to establish some error for our distributions (ie we will use the distributions that we determined from the salinity distribution to establish a range of initial conditions). We are looking into the possibility of doing similar ensemble forcasting for a range of growth and mortality parameters.

March 2006 through August 2006

Food web changes that result in increases or decreases in phytoplankton may affect water quality and may determine the success of higher trophic level animals. Similarly, changes in phytoplankton biomass, availability of contaminants, and availability of organisms that bioaccumulate contaminants will affect the trophic transfer of contaminants in the system. Thus, two of the primary objectives of the CASCADE study are to establish the distribution and magnitude of phytoplankton biomass and to determine the level of bioaccumulation of Hg, Se, and Cd in the Delta and North Bay for prescribed scenarios. The goal of Task 6 is to develop simple models to determine the biomass of two filter-feeding bivalves (*Corbula amurensis* and *Corbicula fluminea)* that have the potential to limit the production of phytoplankton and are capable of bioaccumulating contaminants in a full variety of habitats in the Delta and North Bay.

We are compiling the environmental and bivalve data necessary to derive the model parameters. This includes the compilation of USGS and CA Dept. of Water Resources data from stations in Carquinez Straits, through the North Bay and into the Delta. Our first set of analyses has included examining the time series of *Corbicula* abundance data at a south central location in the Delta to determine if recruitment can be related to export/inflow water ratios and West Outflow parameter (DWR data), fish barrier position, and the relative flows between the Sacramento and San Joaquin Rivers. We are now compiling the data available for biomass at that location to see if there is a relationship between bivalve growth rate and the transport of San Joaquin River-derived phytoplankton. We are also completing an analysis of Delta-wide *Corbicula* distribution (abundance and biomass) and how the distribution of new recruits and adults is related to the following: hydrologic conditions, possible sources of advected phytoplankton, known sources of locally produced phytoplankton, temperature, salinity, and habitat parameters (includes size of waterway, natural vs man-made infrastructure, morphology of channel if appropriate). The recent spread of *Corbula* up river with a change in fall water export schedules has allowed us to examine the fall recruitment and increased survival into adulthood of this bivalve during periods when salt water extends up river for a short time period.

In discussions with the hydrodynamic (Monsen) and phytoplankton (Lucas) modelers we have established a protocol for how to connect the phytoplankton and bivalve models and established a timeline for variables needed from the hydrodynamic model to establish habitat type in the Delta and North Bay.

We have compiled the information for data sources and availability of data. The analyses of some of the *Corbicula* recruitment and biomass data has been started at the south central Delta locations. Our analyses of the *Corbicula* data shows there to be at least a weak relationship between West Outflow (SJR water flow past Jersey Pt is negative with “reverse” flow) and *Corbicula* abundance. Analyses of the *Corbula* distribution data shows that increasing salinity in fall increases the success of bivalve recruitment in the Sacramento River and down to the confluence which increases their biomass by the next summer.

TASK 7: NATIVE AND ALIEN FISH POPULATION TRENDS

September 2006 through February 2007

We continue to compile the bibliography regarding effects of climate change on fish populations. We have started summarizing collected information of the environmental tolerances of our fish species of interest. This information will feed directly into the life cycle models. We have also begun summarizing past work on effects of climate change on fish populations. We are currently considering producing a simple review article for a journal.

I recruited Christa Woodley, a finishing PhD student with Dr. Joseph Cech at University of California Davis to apply for a CALFED fellowship to work on the CASCADE project. I introduced Christa to the project and helped her with her application package. Christa was selected to receive a fellowship and will be developing more detailed dynamic energy budget models. I am acting as Christa's community mentor, basically facilitating her interactions with the CASCADE Team. Dr. Bill Bennett and Dr. Peter Moyle will be acting as Christa's research advisors at University of California Davis.

March 2006 through August 2006

I (Larry Brown) used the funds for this period to pay a biological technician to do library research under my direction. We have assembled a bibliographical database of approximately 130 articles documenting the different methods previous researchers have used to infer effects of climate change on fish populations or assemblages. We have also started to compile information on the temperature tolerances and other physiological and habitat needs of species that might be affected by climate change.

I met with Bill Bennett (UC Davis) and Jan Thompson to better define the information needs of the biology portions of CASCADE (Tasks 6 and 7). Notes regarding the outcome of that meeting were distributed to the CASCADE PIs.

Bill Bennett and I met with Susan Ustin (slustin@ucdavis.edu) and Sepalika Rajapakse (srajapakse@cstars.ucdavis.edu) of the Center for Spatial Technologies And Remote Sensing (CSTARS, http://www.cstars.ucdavis.edu/) at UCD with regard to their mapping of Egeria beds in the Delta.. Susan Ustin (Director of the Center) and Sepalika are very interested in collaborating with us. They have some great data and are interested in making the biological connections from their imagery to the ecosystem. They currently have aerial hyperspectral surveys of SAV for the last 3 years (2003-2005) with imagery from mid- to late June for the entire Delta and partial coverages for 2002. They also have partial imagery for October of last year. These data are available as GIS shape files and they are willing to provide the files to CASCADE. This information was forwarded to Nancy Monsen to be forwarded to the GIS folks helping with CASCADE.

TASK 8: PROJECT ADMINISTRATION

September 2006 through February 2007

Multiple meetings were organized, and budget and report preparation were undertaken as usual. Also, a project server was purchased for internal use, and ultimately to provide CASCaDE with a public web presence. Several meetings with our IT staff were held to coordinate setup of this server, and to design the interface by which it will be accessed by team members. Server setup is underway and it should be ready for initial team usage within a couple of months. A public web presence beyond our current portal (http://sfbay.wr.usgs.gov/cascade) is not anticipated this year.

March 2006 through August 2006

This has been the project "spin-up" period—getting individual accounts in place, beginning the process of hiring postdocs, etc. At the same time, the real work of the project has gotten well underway, as discussed in this report. As part of Task 8, multiple team meetings have been organized, with non-Menlo Park members attending via videoconference. CASCaDE meetings have taken place on February 22-23, March 22, March 27, April 28, May 19, and July 17, with another meeting planned for September 8. Numerous smaller meetings have also been attended by team members, including Mike Dettinger's presentation at the California Water and Environmental Modeling Forum, March 1, 2006, Jim Cloern and Lisa Lucas' presentation at the Western Region Water Science Symposium, March 21, 2006, Nancy Monsen's attendance at the Delta Risk Management Strategy Meeting, May 8, 2006, and Neil Ganju's attendance of the Delta Vision Conference, June 6-7, 2006. As part of Task 8, relevant notes and materials from these meetings have been assembled and posted regularly on the CASCaDE Project internal website. Other completed administrative tasks include budget management and production of this report.